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(54) **SERVICE TUBE ASSEMBLY FOR A GAS TURBINE ENGINE**

BETRIEBSROHRANORDNUNG FÜR EINEN GASTURBINENMOTOR

ENSEMBLE TUBE DE SERVICE POUR MOTEUR DE TURBINE À GAZ

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(56) References cited:
WO-A1-2015/132540 **GB-A- 873 886**
US-A- 2 497 987 **US-A1- 2019 128 454**

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Description

TECHNICAL FIELD

[0001] The application relates generally to gas turbine engines and, more particularly, to service tube assemblies.

BACKGROUND OF THE ART

[0002] Service tubes fluidly couple different portions of a gas turbine engine or couple portions of the engine to other associated components, such as aircraft components. The service tubes can, for instance, supply oil or an oil/air mixture to and/or from the engine and between the different portions of the engine. Due to tolerance stack-up, the tube ends may not always perfectly coincide with their points of attachment on the engine. Such tolerance stack-up may result in undesirable stresses in the tubes at cold assembly.
Tube assembly alternatives are, thus, desirable.
US 2497987 A discloses an adjustable connection for pipes, WO 2015/132540 A1 discloses a turbojet engine nacelle with a flexible hydraulic fitting comprising a length adjustment, and GB 873886 A discloses improvements relating to pipe connectors.

SUMMARY

[0003] The present invention provides a gas turbine engine as set forth in claim 1.
[0004] Embodiments of the disclosure are set forth in the dependent claims.

DESCRIPTION OF THE DRAWINGS

[0005] Reference is now made to the accompanying figures in which:

Fig. 1 is a schematic cross-section view of a gas turbine engine having a tube assembly with an adjustable joint between a compressor and an exhaust section of the engine;
Fig. 2 is a schematic cross-section view of the tube assembly illustrating the adjustable joint in a partially engaged state;
Figs. 3a and 3b are isometric views of the adjustable joint respectively shown in a partially and a fully assembled state;
Fig. 4 is an enlarged cross-section view illustrating details of the adjustable joint;
Fig. 5 is a cross-section view of another example of a tube assembly in which a service tube is fluidly connected to an engine component, such as an accessory unit; and
Fig. 6 is an enlarged cross-section view of an example of an adjustable joint between two service tubes not falling within the scope of the claimed invention.

DETAILED DESCRIPTION

[0006] Fig. 1 illustrates a gas turbine engine 10 of a type preferably provided for use in subsonic flight, generally comprising in serial flow communication an air inlet 11, a compressor 12 for pressurizing the air from the air inlet 11, a combustor 13 in which the compressed air is mixed with fuel and ignited for generating an annular stream of hot combustion gases, a turbine 14 for extracting energy from the combustion gases, and an exhaust 15 through which the combustion gases exit the engine 10. The turbine 14 includes a low pressure or power turbine 14a drivingly connected to an input end of a reduction gearbox RGB 16. The RGB 16 has an output end drivingly connected to an output shaft 18 configured to drive a rotatable load (not shown). The rotatable load can, for instance, take the form of a propeller or a rotor, such as a helicopter main rotor. The gas turbine engine 10 has an engine centerline 17. According to the illustrated embodiment, the compressor and the turbine rotors are mounted in-line for rotation about the engine centerline 17.
[0007] The gas turbine engine 10 has an axially extending central core which defines an annular gaspath 20 through which gases flow, as depicted by flow arrows in Fig. 1. It is understood that the engine could adopt different configurations, the engine configuration illustrated in Fig. 1 being provided for context purposes only. For instance, the engine could be configured as a turboprop, a turboshaft, a turbofan or an auxiliary power unit (APU) in a through flow or reverse flow arrangement.
[0008] As schematically exemplified in Fig. 1, the engine 10 is equipped with a plurality of tubes for transporting a fluid, such as oil, coolant, air, a liquid-gas mixtures (e.g. an oil-air mixture) or fuel, between different portions of the gas turbine engine 10. These tubes are herein referred to as service tubes and include, among others, tubes used to supply oil to a bearing sump (an "oil supply tube"), to drain spent oil from the bearing sump (a "drain" or "scavenge tube"), to pressurize the bearing sump with air (a "pressure tube"), and to vent air from the bearing sump (a "ventilation tube").
[0009] More particularly, Fig. 1 illustrates an exemplary service tube assembly 22 used to convey a fluid (e.g. oil, air, an oil-air mixture) between the compressor 12 and the exhaust 15. However, it is understood that the tube assembly 22 could be used to fluidly interconnect other portions of the engine 10 and to convey fluids other than oil, air or an air-oil mixture, the illustrated embodiment being representative of only one of the contemplated applications.
[0010] In practice, the exact position of the points of attachment to the compressor 12 and the exhaust 15 at opposed ends of the tube assembly 22 may vary due to the accumulation of tolerance stack-up at assembly. Therefore, the tube(s) may need to be slightly deformed to permit joining of the tube extremities to the associated points of attachment on the engine. In some instances,

this may induce undesirable stresses in the tubes. For instance, the inherent resiliency of "stiff" materials, such as titanium, may result in undue stress in the tubes at cold assembly when the tube extremities do not perfectly mate with the associated fixed attachment points on the engine. Accordingly, ductile materials (i.e. less stiffer materials), such as Inconel alloy 625 or stainless steel (SST), are typically used to accommodate tube deformation at assembly. However, Inconel alloy 625 and stainless steel tubes are heavier than titanium tubes, resulting in heavier engines. It is thus desirable to reduce the stress induced in the service tubes at cold assembly.

[0011] As will be seen herein after, the service tube assembly 22 has an adjustable joint 24 to accommodate the accumulation of tolerance stack-up (and thus the geometrical and position variations at the points of attachment of the service tubes) and, thus, reduce or mitigate installation stresses induced in the tubes at cold assembly. This may provide more flexibility in the choice of materials for the tubes. For instance, it may allow to replace conventional IN625 or SST tubes with stiffer and lighter tubes, such as titanium tubes, in a gas turbine engine oil line extending from the compressor 12 to the exhaust 15 and that without compromising the oil line integrity.

[0012] Referring jointly to Figs. 1, 2 and 4, it can be seen that the exemplified service tube assembly 22 comprises a first tube 26 and a second tube 28 joined together at the adjustable joint 24. The adjustable joint 24 comprises first and second fittings 30, 32 respectively provided at the adjoining ends of the first and second tubes 26, 28. The first and second fittings 30, 32 can be brazed or otherwise suitably secured to the adjoining ends of the first and second tubes 26, 28, respectively. As shown in Fig. 2, the first and second fittings 30, 32 are engaged in male/female connection. According to the illustrated example, the second fitting 32 has a cylindrical male portion 32a adjustably, axially insertable in sealing engagement within a corresponding cylindrical female portion 30a of the first fitting 30. However, it is understood that the male/female role between the first and second fittings 30, 32 could be inversed (i.e. the first fitting could have a male portion extending into a female portion of the second fitting). A seal is provided between the male and female portions 32a, 30a. According to the illustrated example, the seal is provided in the form of a pair of axially spaced-apart O-rings 34 mounted in corresponding annular grooves defined in the outer circumferential surface of the male portion 32a of the second fitting 32 and axially positioned for engagement with a radially inner circumferential surface of the female portion 30a of the first fitting 30. It is understood that more or less O-rings or seals could be provided along the male portion 32a of the first fitting 32.

[0013] Still referring to Figs. 2 and 4, the first tube 26 has a first abutment surface 36 fixedly positioned at the distal end of the first fitting 30. The second tube 28 has a second abutment surface 38 adjustably mounted to the second fitting 32. According to the illustrated example, the first and second abutment surfaces 36, 38 are respectively provided on a first flange 40 and a second flange 42. As can be appreciated from Figs 2, 3a, 3b and 4, the position of the first flange 40 is fixed at the distal end of the first fitting 30 and the position of the second flange 42 is axially adjustable along the second fitting 32.

[0014] According to the illustrated example, the second flange 42 has a threaded portion 42a threadably engaged with a corresponding threaded portion 32b on the second fitting 32. According to the illustrated example, the second flange 42 has a tubular body including inner threads formed at an inner diameter thereof for threaded engagement with corresponding outer threads provided on an outer surface of the second fitting 32. The male portion 32a of the second fitting 32 projects axially beyond the threaded portion 32b. Stated differently, the threaded portion 32b is disposed axially inboard of the distal male portion 32a of the second fitting 32. The axial position of the second flange 42 along the second fitting 32 can be adjusted so that the male portion 32a projects more or less from the second flange 42. The position of the second flange 42 can be adjusted by simply rotating the second flange 42 on the second fitting 32. As shown in Figs. 3a and 3b, the tubular body of the second flange 42 can have a hexagonal end portion 42b for engagement with a tool, such as a wrench.

[0015] The tube assembly 22 is installed on the engine 10 by first inserting the male portion 32a of the second fitting 32 of the second tube 28 into the female portion 30a of first fitting 30 of the first tube 26. At this preliminary stage of assembly, the preassembled first and second tubes 26, 28 are adjustably telescopically engaged and free to axially move relative to one another. Once the adjustable extremity of the second tube 28 has been so engaged with the adjoining extremity of the first tube 26, the opposed ends 26a and 28a of the first and second tubes 26, 28 are securely connected to their respective points of connection/attachment on the exhaust 15 and the compressor 12. Thereafter, the second flange 42 (i.e. the threaded flange) is rotated on the second fitting 32 so as to bring the second abutment surface 38 firmly against the first abutment surface 36 of the first flange 40 at the distal end of the first fitting 30 of the first tube 26. This can be appreciated from Figs. 3a and 3b. After having firmly abutted the second abutment surface 38 against the first abutment surface 36, the first and second abutment surfaces 36, 38 are clamped together. This can be accomplished in a variety of ways and through the use of different fasteners. For instance, according to the embodiment illustrated in Figs. 2, 3a and 3b, the first and second flanges 40, 42 can be bolted together. According to one aspect, the second flange 42 can be provided with a pair of bolt holes for alignment with corresponding bolt holes in the first flange 40 (see Fig. 3a). Accordingly, once the second flange 42 has been brought into firm engagement with the first flange 40, the angular position of the second flange 42 relative to the first flange 40 is adjusted to bring the bolts holes of the flanges 40, 42 in registry. Then, bolts 46 are inserted through the registering holes and nuts 48 threaded on the bolts 46 to secure the assembly as shown in Fig. 3b.

[0016] According to one aspect, the adjustable flange and male/female connection allow to eliminate or at least reduce the stresses resulting from the accumulation of tolerance stack-up at assembly. According to another aspect, after the second flange 42 has been brought in firm contact against the first flange 40, the second flange 42 can be further rotated by a predetermined number of turns so as to pre-load the tube assembly in such a way as to counteract stresses resulting from thermal expansion during engine operation. The adjustable joint 24 may thus accommodate thermal effects and tolerance stack-up with its male-female interaction and adjustable clamping assembly.

[0017] Now referring to Fig. 5, it can be appreciated that the above described adjustable joint is not limited to a junction between two service tubes but could also be applied at the interface or connection between a service tube an any other mating components. For instance, the second tube 28 with its threaded flange 42 could be used to fluidly connect the second service tube 28 to an accessory unit 50, such as a pump or the like. According to this embodiment, the accessory unit 50 has a fixed mounting surface 52 defining a port 54 for receiving the male portion 32a of the second fitting 32 in a male/female connection. Holes (not shown) are defined in the mounting surface 52 for alignment with the bolt holes in the adjustable flange 42 of the service tube 28. The position of the adjustable flange 42 is adjusted to firmly abut the flange 42 in abutment against the mounting surface 52 and to align the bolt holes on the flange 42 in registry with the bolt holes in the mounting surface 52 of the accessory unit 50.

[0018] Fig. 6 illustrates an example of an adjustable joint 24' with a male/female connection between two service tubes 26', 28' not falling within the scope of the claimed invention. According to this example, the first abutment surface 36' of the first service tube 26' is provided at the distal end of the first fitting 30' around the female portion 30a' receiving the male portion 32a' of the second fitting 32' of the second tube 28'. The second abutting surface 38' is provided at the end of an adjustable nut 42' threadably engaged with the externally threaded portion 32b' of the second fitting 32'. As can be appreciated from Fig. 6, the axial position of the nut 42' on the second fitting 32' can be adjusted by rotating the nut 42' until it axially abuts against the terminal end (the first abutment surface) of the first fitting 30' of the first service tube 26'. According to this example, the first and second abutment surfaces 36', 38' are clamped together by a single fastener. The fastener may be provided in the form of a hexagonal tube fitting 46' having an inner annular shoulder 46a' at a first end portion thereof engaged behind a corresponding outer annular shoulder 42a' projecting from the adjustable nut 42'. The hexagonal tube fitting 46' has inner threads 46b' at a second end portion for threaded engagement with corresponding outer threads 30b' formed on an outer surface of the first fitting 30' of the first tube 26'. The hexagonal tube fitting 46' can thus be tightened on the first fitting 30' to firmly axially clamp the first and second abutment surfaces 36', 38' together after the position of the nut 42' has been adjusted to compensate for the accumulation of the tolerance stack-up at assembly.

[0019] According to one aspect, at least some of the above described embodiments allows for the installation of tubing in a gas turbine engine with a substantial cold stack up variation. The provision of a tube assembly with an adjustable joint may allow to compensate for build stack-up accumulation and thus to lower stress in the service tubes.

[0020] According to a further aspect, the adjustable joint comprises a rotatable flange using a threaded feature to axially position the abutment surface at the resultant axial position. This may allow to accommodate some engine length variations due to manufacturing tolerances.

[0021] At least some embodiments allow for the use of stiffer tube material, such as titanium tubing. It provides more flexibility in the choice of material for the service tubes. For instance, it may allow for the use of lighter tubes.

[0022] The embodiments described in this document provide non-limiting examples of possible implementations of the present technology. Upon review of the present disclosure, a person of ordinary skill in the art will recognize that changes may be made to the embodiments described herein without departing from the scope of the present technology. For example, an additional O-ring could be positioned on the male portion of the second fitting to seal against the inner surface of the adjustable flange. Yet further modifications could be implemented by a person of ordinary skill in the art in view of the present disclosure, provided such modifications fall within the scope of the appended claims.

Claims

1. A gas turbine engine (10), comprising:

   an engine component (26; 50) having a first fitting (30) and a first abutment surface (36; 52);
   a service tube (28) fluidly connected to the engine component (26; 50), the service tube (28) having a second fitting (32) at one end thereof and an adjustable flange (42), the second fitting (32) engaged in a male/female connection with the first fitting (30) of the engine component (26; 50), the second fitting (32) having a threaded portion (32b), the adjustable flange (42) threadably engaged with the threaded portion (32b) of the second fitting (32) for adjusting a position of the adjustable flange (42) along the second fit-

ting (32) so as to bring a second abutment surface (38) of the adjustable flange (42) in abutment against the first abutment surface (36; 52), the adjustable flange (42) having bolt holes for alignment with corresponding bolt holes in the first abutment surface (36; 52); and
fasteners (46, 48) including bolts insertable in the bolt holes for clamping the first and second abutment surfaces (36, 38) together.

2. The gas turbine engine according to claim 1, wherein the engine component (26) is another service tube (26).

3. The gas turbine engine according to claim 1 or 2, wherein the first abutment surface (36) is part of a first flange (40) extending from the first fitting (30).

4. The gas turbine engine according to any of claims 1 to 3, wherein the threaded portion (32b) includes external threads provided on an outer surface of the second fitting (32), and the adjustable flange (42) has internal threads threadably engaged with the external threads.

5. The gas turbine engine according to any of claims 1 to 4, wherein the second fitting (32) has a male portion (32a) projecting beyond the threaded portion (32b) for mating engagement within a female portion (30a) of the first fitting (30).

6. The gas turbine engine according to claim 5, wherein spaced-apart O-rings (34) are provided between the male portion (32a) and the female portion (30a).

Patentansprüche

1. Gasturbinenmotor (10), Folgendes umfassend:

eine Motorkomponente (26; 50), die eine erste Armatur (30) und eine erste Anschlagfläche (36; 52) aufweist;
ein Betriebsrohr (28), das mit der Motorkomponente (26; 50) fluidverbunden ist, wobei das Betriebsrohr (28) an seinem einen Ende eine zweite Armatur (32) und einen einstellbaren Flansch (42) aufweist, wobei die zweite Armatur (32) in einer Steckverbindung mit der ersten Armatur (30) der Motorkomponente (26; 50) in Eingriff steht, wobei die zweite Armatur (32) einen Gewindeabschnitt (32b) aufweist, wobei der einstellbare Flansch (42) gewindemäßig mit dem Gewindeabschnitt (32b) der zweiten Armatur (32) in Eingriff steht, um eine Position des einstellbaren Flansches (42) entlang der zweiten Armatur (32) einzustellen, um eine zweite Anschlagfläche (38) des einstellbaren Flansches (42) in Anschlag gegen die erste Anschlagfläche (36; 52) zu bringen, wobei der einstellbare Flansch (42) Bolzenlöcher zur Ausrichtung mit entsprechenden Bolzenlöchern in der ersten Anschlagfläche (36; 52) aufweist; und
Befestigungselemente (46, 48) einschließlich Bolzen, die in die Bolzenlöcher einsetzbar sind, um die erste und die zweite Anschlagfläche (36, 38) zusammenzuklemmen.

2. Gasturbinenmotor nach Anspruch 1, wobei die Motorkomponente (26) ein weiteres Betriebsrohr (26) ist.

3. Gasturbinenmotor nach Anspruch 1 oder 2, wobei die erste Anschlagfläche (36) Teil eines ersten Flansches (40) ist, der sich von der ersten Armatur (30) aus erstreckt.

4. Gasturbinenmotor nach einem der Ansprüche 1 bis 3, wobei der Gewindeabschnitt (32b) Außengewinde beinhaltet, die auf einer Außenfläche der zweiten Armatur (32) bereitgestellt sind, und der einstellbare Flansch (42) Innengewinde aufweist, die gewindemäßig mit den Außengewinden in Eingriff stehen.

5. Gasturbinenmotor nach einem der Ansprüche 1 bis 4, wobei die zweite Armatur (32) einen über den Gewindeabschnitt (32b) hinausragenden männlichen Abschnitt (32a) zum passenden Eingriff in einen weiblichen Abschnitt (30a) der ersten Armatur (30) aufweist.

6. Gasturbinenmotor nach Anspruch 5, wobei zwischen dem männlichen Abschnitt (32a) und dem weiblichen Abschnitt (30a) beabstandete O-Ringe (34) bereitgestellt sind.

Revendications

1. Moteur de turbine à gaz (10), comprenant :

un composant de moteur (26; 50) ayant un premier raccord (30) et une première surface de butée (36; 52);
un tube de service (28) relié fluidiquement au composant de moteur (26; 50), le tube de service (28) ayant un second raccord (32) à une extrémité de celui-ci et une bride réglable (42), le second raccord (32) étant en prise en connexion mâle/femelle avec le premier raccord (30) du composant moteur (26; 50), le second raccord (32) ayant une partie filetée (32b), la bride réglable (42) étant en prise filetée avec la partie filetée (32b) du second raccord (32) pour ajuster une position de la bride réglable (42) le long du second raccord (32) de manière à ame-

ner une seconde surface de butée (38) de la bride réglable (42) en butée contre la première surface de butée (36; 52), la bride réglable (42) ayant des trous de boulons pour un alignement avec des trous de boulons correspondants dans la première surface de butée (36; 52); et
des attaches (46, 48) comportant des boulons pouvant être insérés dans les trous de boulons pour serrer les première et seconde surfaces de butée (36, 38) ensemble.

2. Moteur de turbine à gaz selon la revendication 1, dans lequel le composant de moteur (26) est un autre tube de service (26).

3. Moteur de turbine à gaz selon la revendication 1 ou 2, dans lequel la première surface de butée (36) fait partie d'une première bride (40) s'étendant à partir du premier raccord (30).

4. Moteur de turbine à gaz selon l'une quelconque des revendications 1 à 3, dans lequel la partie filetée (32b) comporte des filetages externes prévus sur une surface externe du second raccord (32), et la bride réglable (42) a des filetages internes mis en prise par filetage avec les fils extérieurs.

5. Moteur de turbine à gaz selon l'une quelconque des revendications 1 à 4, dans lequel le second raccord (32) a une partie mâle (32a) faisant saillie au-delà de la partie filetée (32b) destinée à s'emboîter à l'intérieur d'une partie femelle (30a) du premier raccord (30).

6. Moteur de turbine à gaz selon la revendication 5, dans lequel des joints toriques espacés (34) sont prévus entre la partie mâle (32a) et la partie femelle (30a).

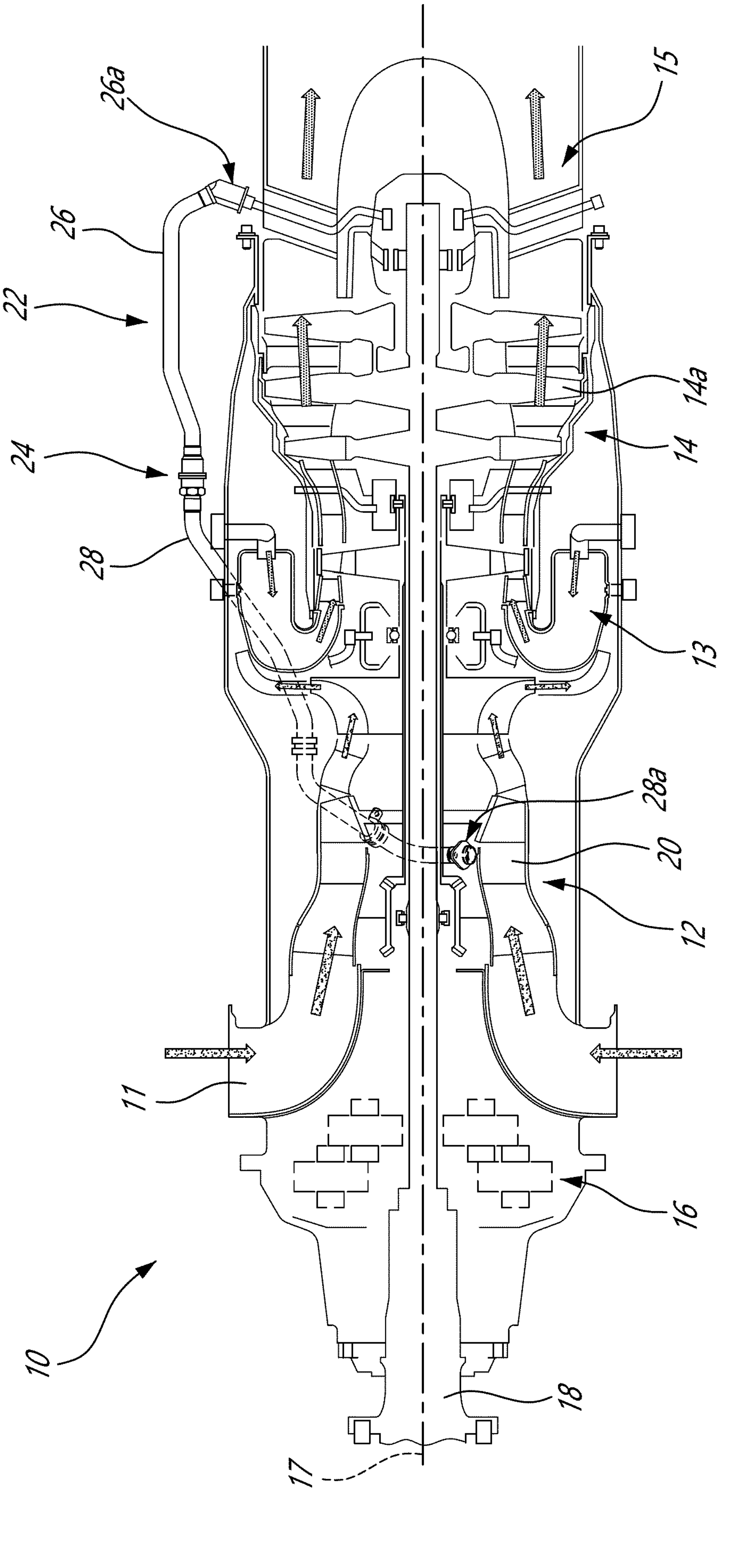

FIG. 1

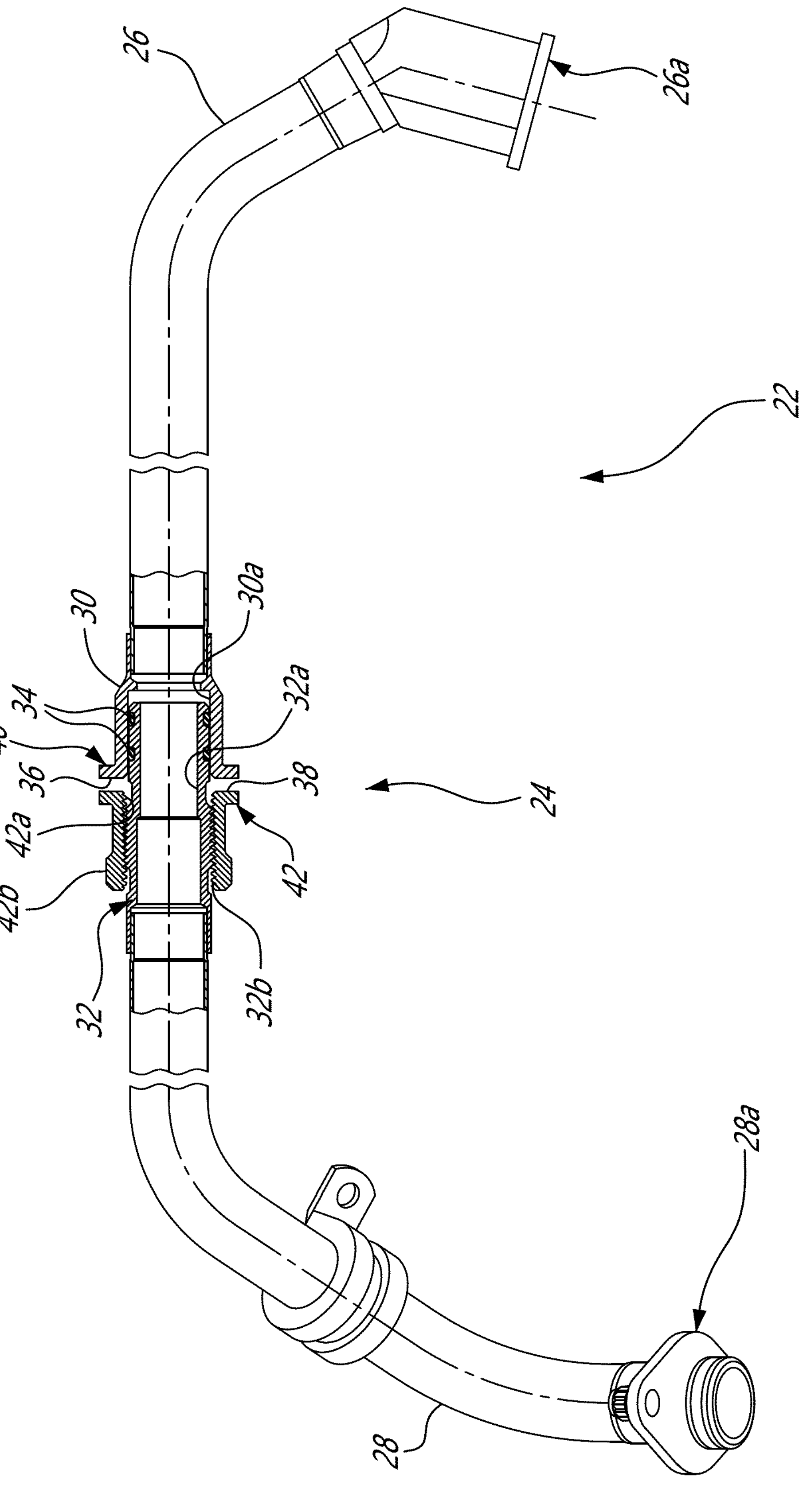

FIG-2

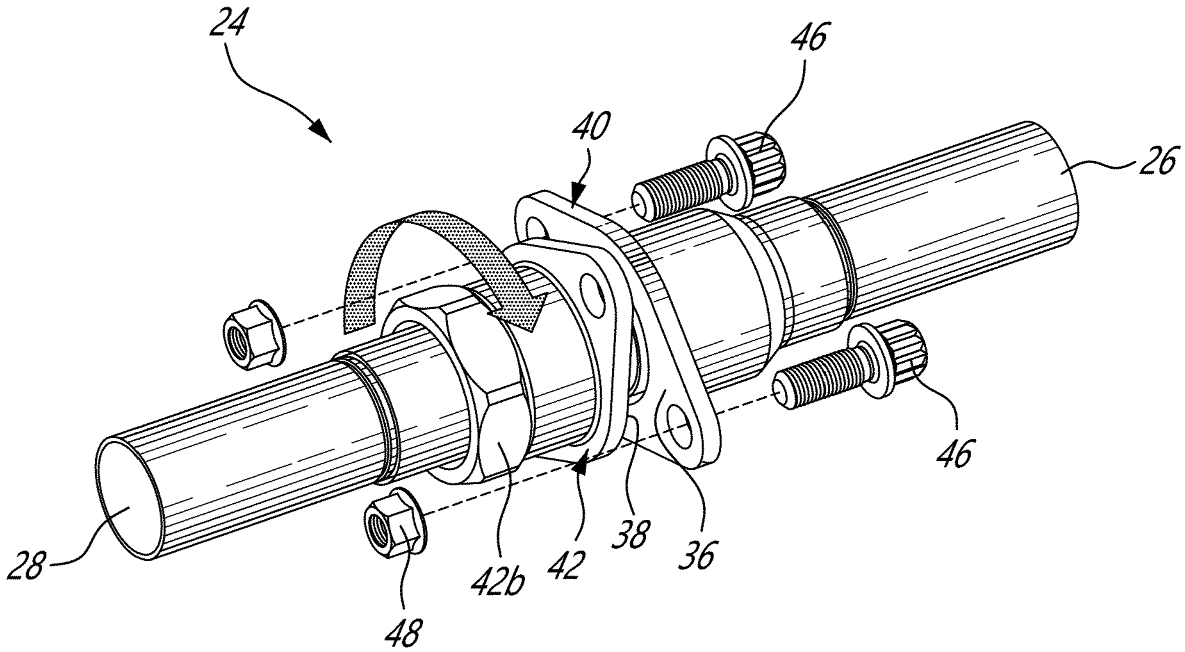

FIG. 3A

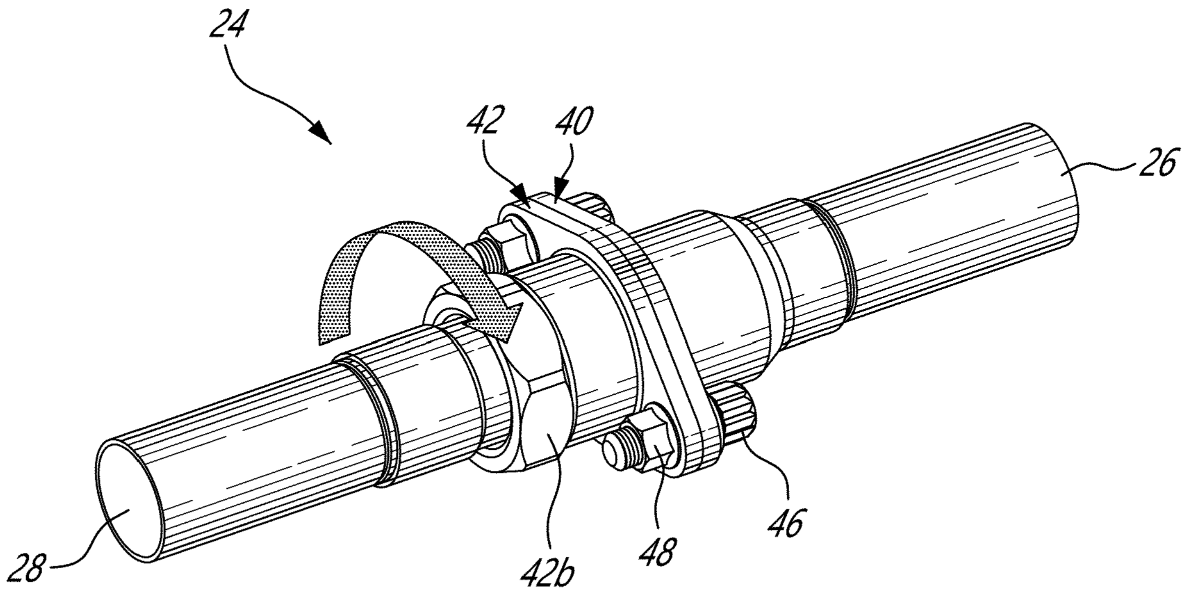

FIG. 3B

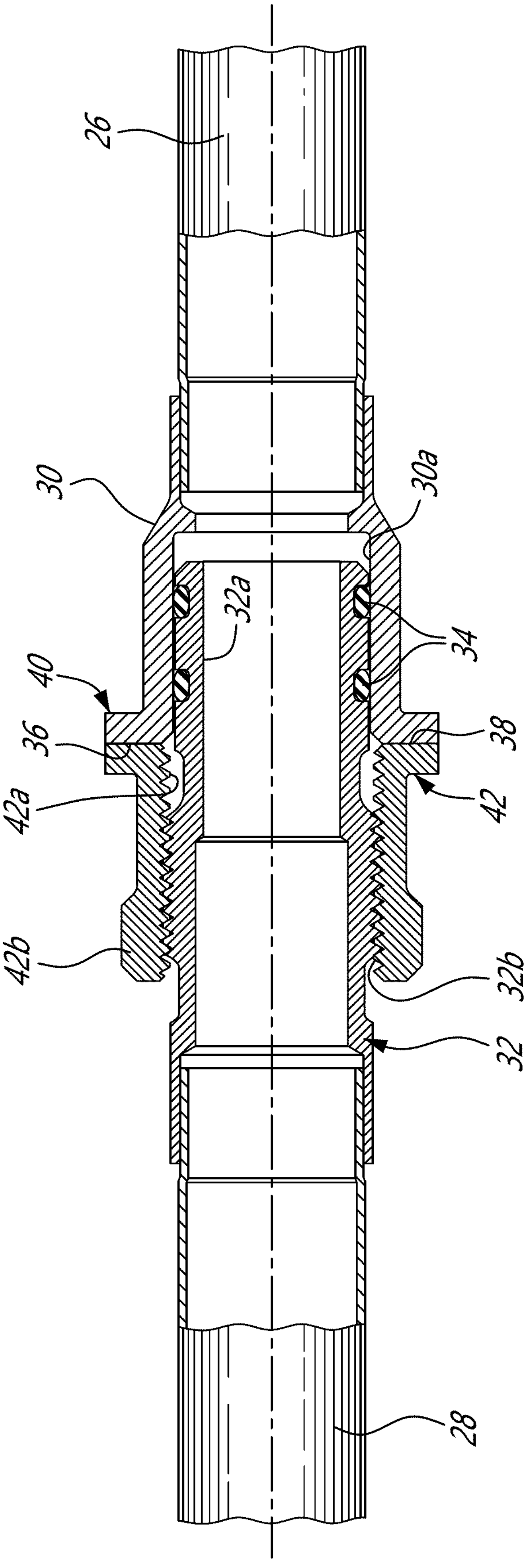

FIG. 4

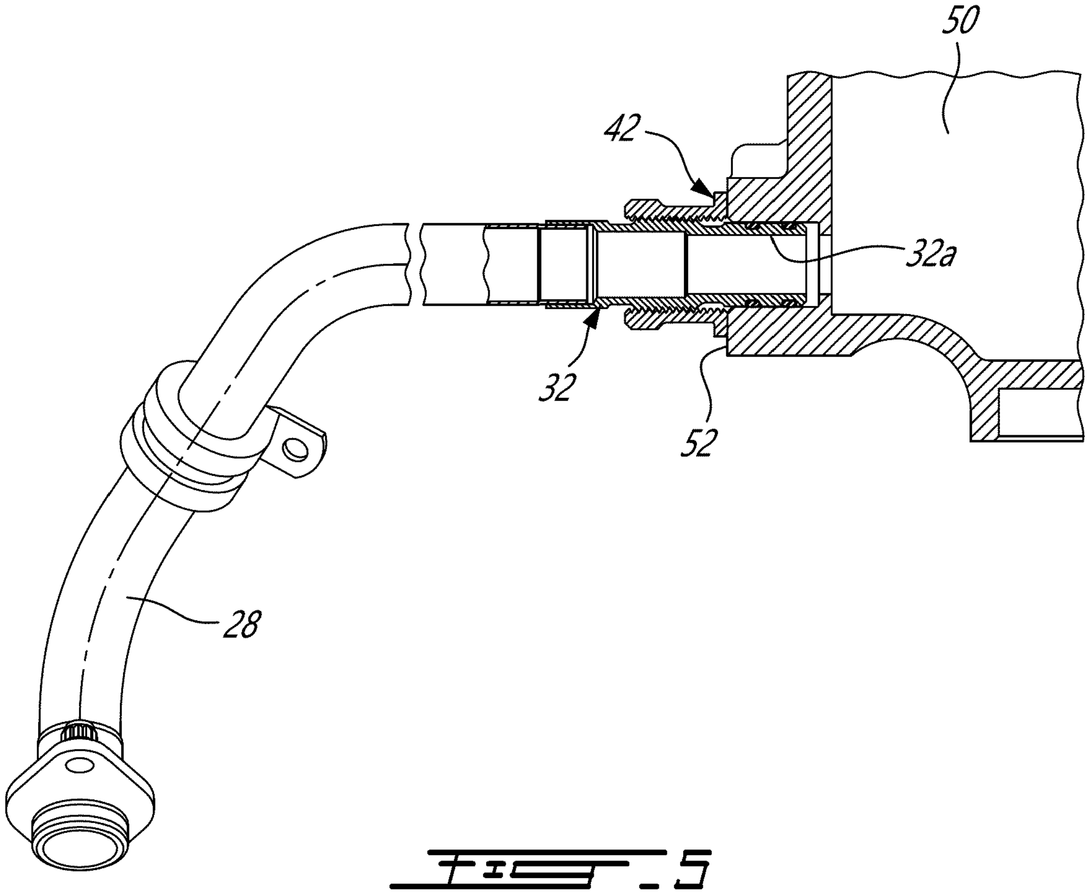
50
42
32a
32
52
28

FIG. 5

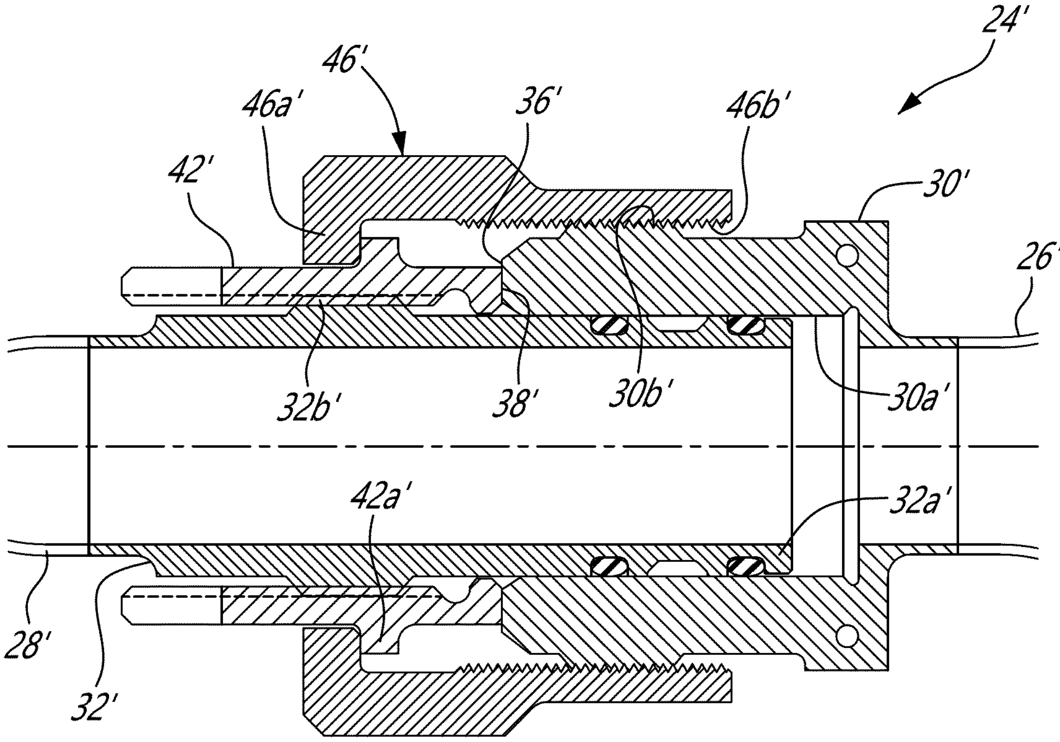
24'
46'
46a'
36'
46b'
42'
30'
26'
32b'
38'
30b'
30a'
42a'
32a'
28'
32'

FIG. 6

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 2497987 A **[0002]**
- WO 2015132540 A1 **[0002]**
- GB 873886 A **[0002]**